NCEP Ocean Modeling

Current status and future directions

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Weather time scale ocean modeling only, Dave Behringer will discuss CFS / MOM4.

History:

- Early 1990's: POM East Coast model:
  - Requirement for SOLAS from OPC.
  - Issues with Gulf Stream Separation.
- Late 1990's short-lived focus on in-house model development (CubOc).
- After that: HYCOM Consortium
  - Coalition of the willing with similar mission/requirements.
  - Major Navy input (NRL, ONR).
  - Several academic partners.
  - 2005 implementation of RTOFS-Atlantic (HYCOM).

History cont'ed:

- 2004/5 NOAA SAB board: create NOAA Ocean Backbone Capability (weather time scales) with:
  - Global and basin responsibility for NCEP.
  - Coastal and regional responsibilities for NOS.
    - Moving operational models to ops. computers.
  - Coastal and regional private-public partnership with IOOS Regional Associations.

- January 2008 workshop at NCEP to align NCEP plans better with SAB.
  - Focus on RTOFS-Global first (NRL HYCOM)
  - Possible only in close collaboration with NRL.

RTOFS

Five major efforts:

- Eddy resolving ocean modeling.
- Eddy resolving ocean initialization.
  - Operational 2005 — RTOFS-Atlantic
  - Operational 10/25/2011 — RTOFS-Global
- Coupled modeling for hurricanes.
  - Live testing — nested RTOFS coupled to HWRF
- Coupled modeling for weather – CFS / NEMS.
  - Under development — RTOFS-NEMS
- Episodic tracers (with shelf life)
  - Operational 07/24/2012 — RTOFS-ET-Pac

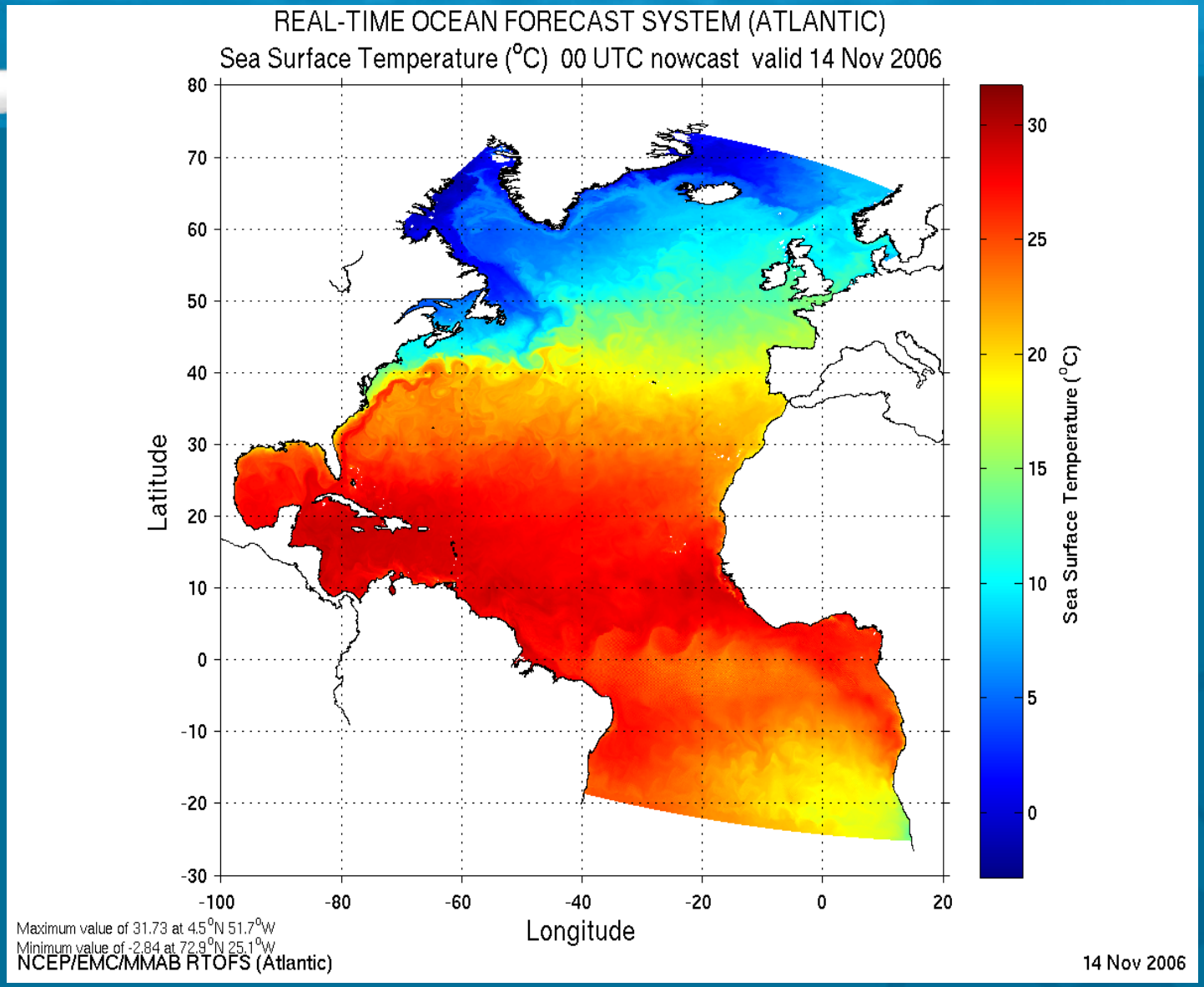
- All RTOFS models presently based on HYCOM
  - RTOFS represent line of products.
  - HYCOM is underlying ocean model.

RTOFS-Atlantic

- First full HYCOM model to become operational at NCEP.
- Replacing previous POM model for East Coast (excluding Gulf of Mexico).
- Model with tides, requirement from OPC.

- Issues with model:
  - Left in limbo to get RTOFS-Global in fast.
  - To be nested in RTOFS-Global, boundaries have been headaches.
  - Next decision point: do we keep this model around?
    - Tides.
    - 4-6 km coastal resolution for US.

RTOFS-Atlantic



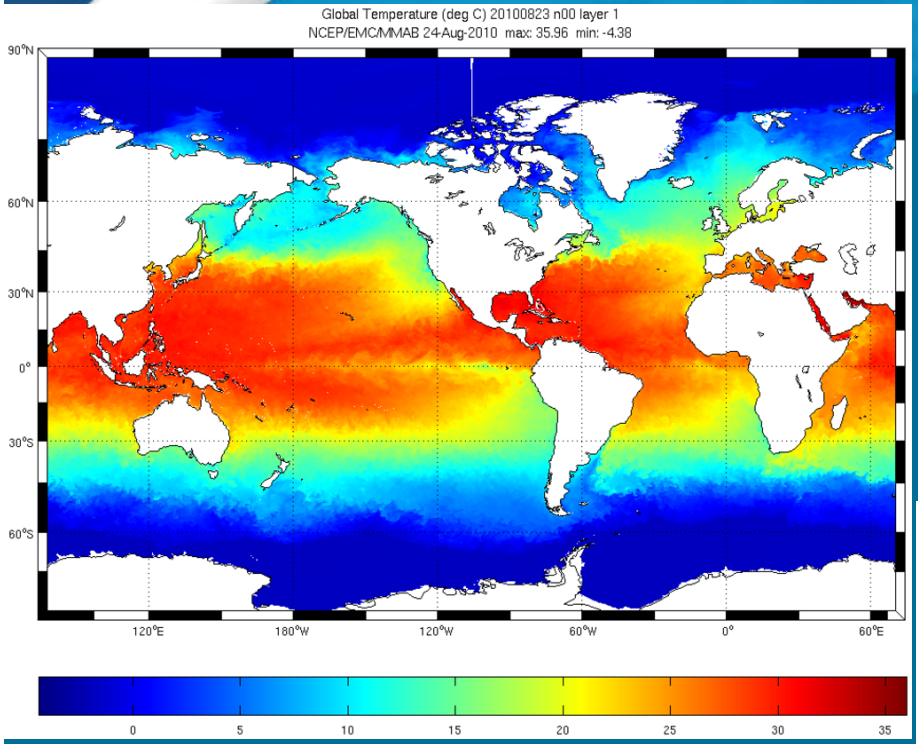
RTOFS-Global

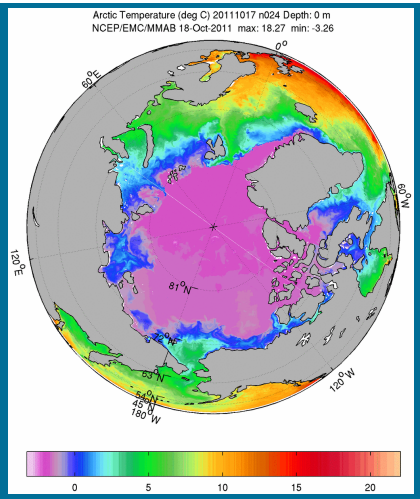
- Push to global model (vs. regional models):
  - Satisfy requirements from NOAA SAB.
  - Provide boundary data for regional models.
- Adopting existing 1/12° model from NRL (NOPP).
  - GFS forcing (including diurnal cycle).
- Timeline:
  - Operational 10/25/2011 with NRL/NAVOCEANO (NCODA) initialization (daily feed from NAVO).
  - FY2014: full initialization at NCEP.

paradigm shift for NWS

- NOMADS as main distribution points (OpenDAP, NetCDF).
- RTOFS-Atlantic as testbed for global.
- Linking to NOS Coastal Ocean Modeling Framework.
- No tides yet (unlike RTOFS-Atlantic)

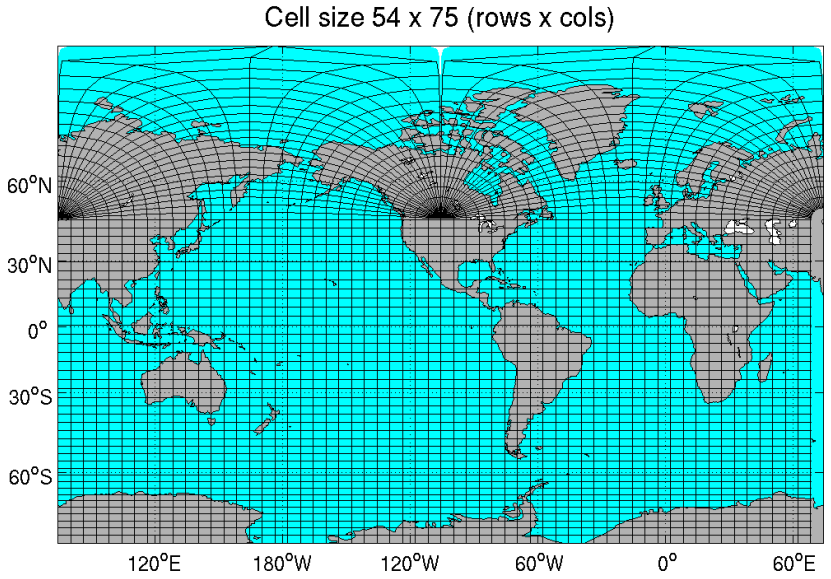
RTOFS-Global



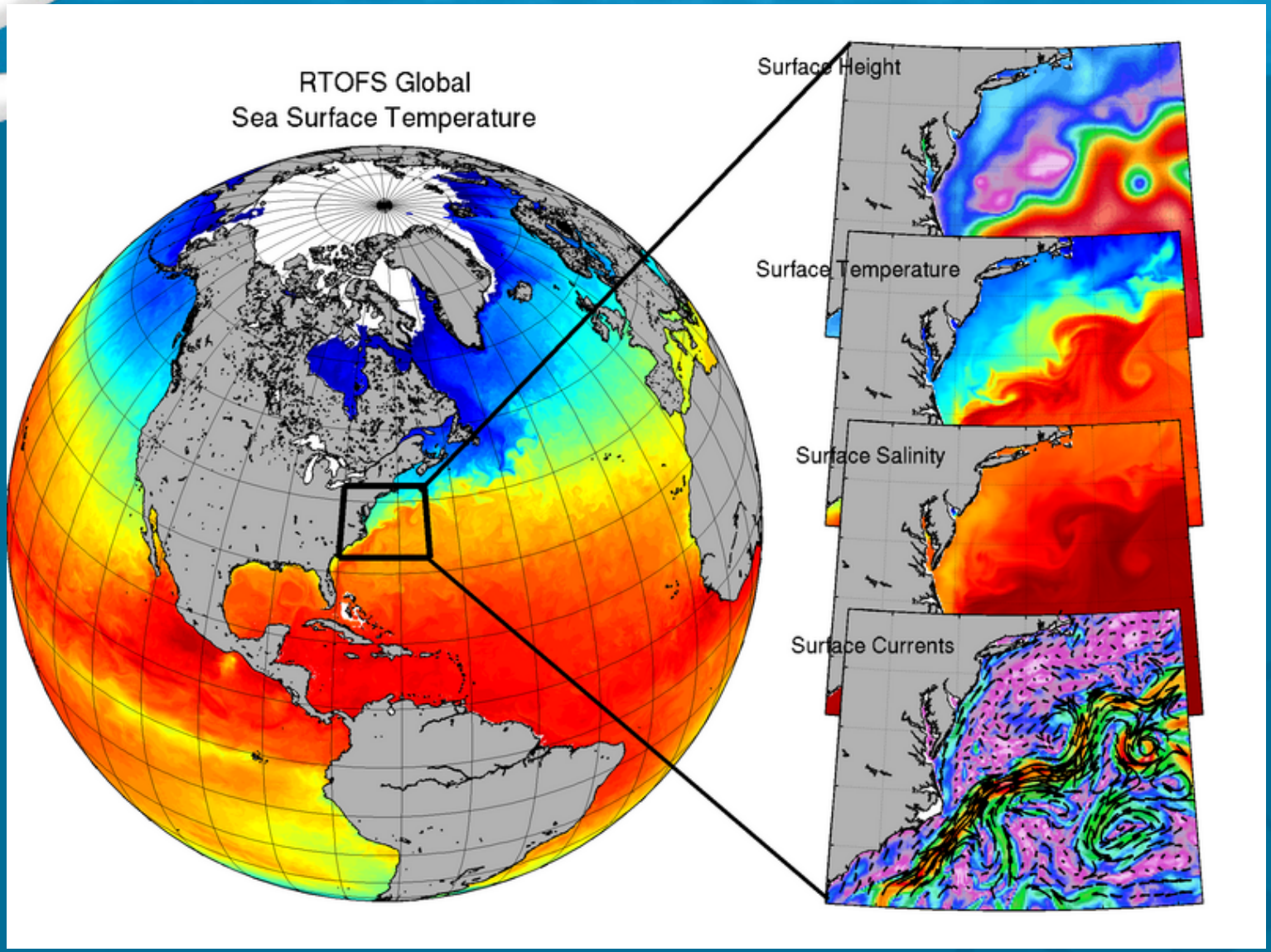


Grid and layer 1 temperature snapshot:

Conversion to GFS forcing "clean"



RTOFS-Global

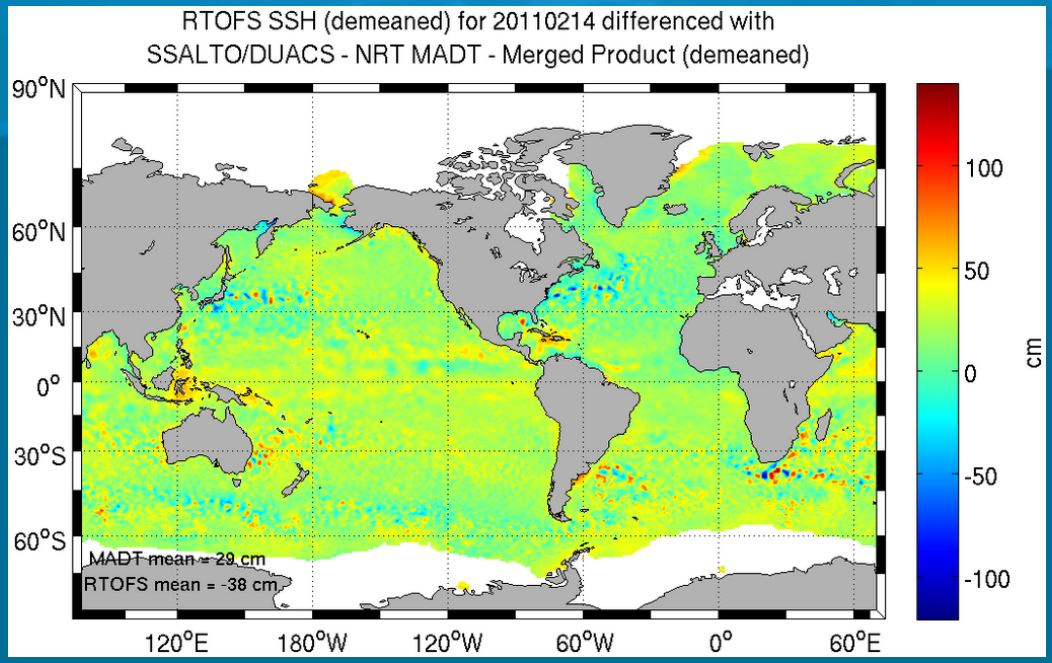


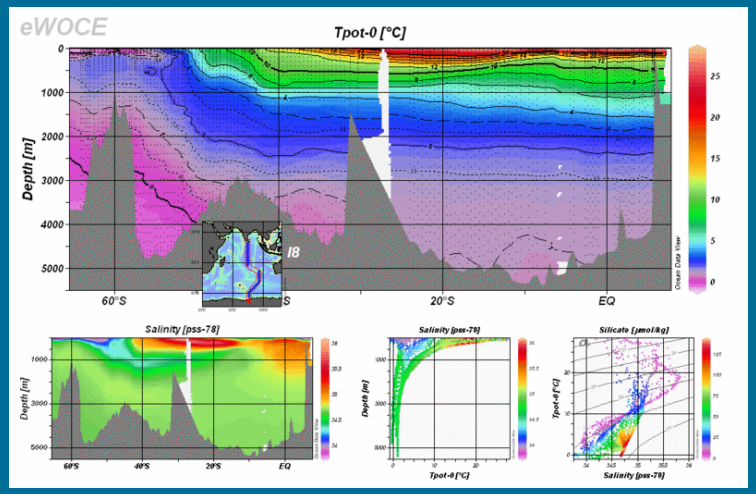
Focus on producing GODAE metrics products

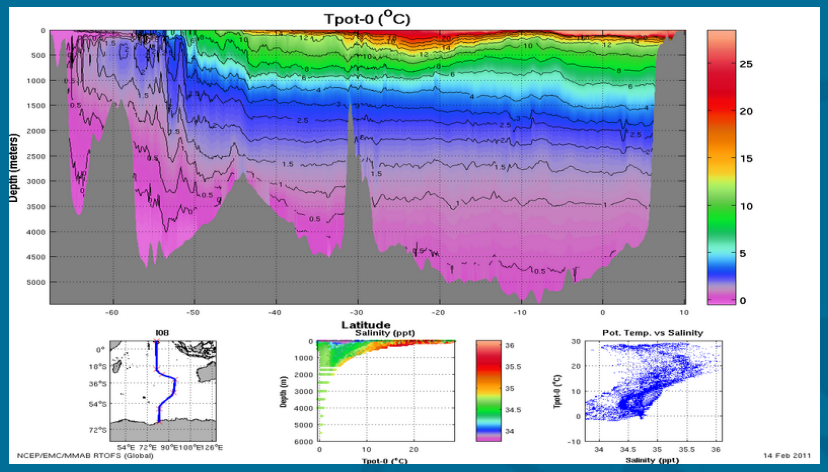
Examples follow:

- Class 1: Differences with SSH fields from independent analyses.
- Class 2: Drifts from climatology at selected WOCE sections.
- Class 3: Location of Gulf Stream.
- Class 3: Transports at more than 100 sections.
- Class 4: Statistics on location of Gulf Stream; Daily comparison with independent SST, SSH data.
- Class 4: Comparisons of forecasts/analysis with ARGO profiles.

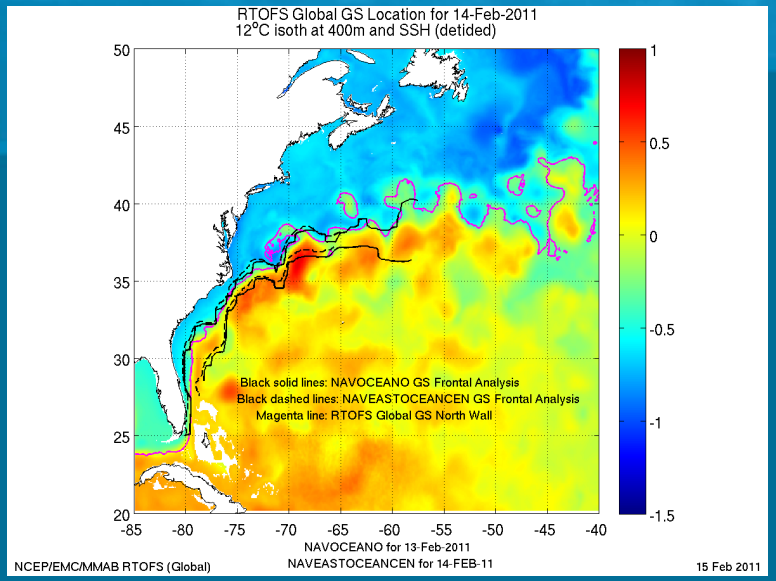
RTOFS-Global

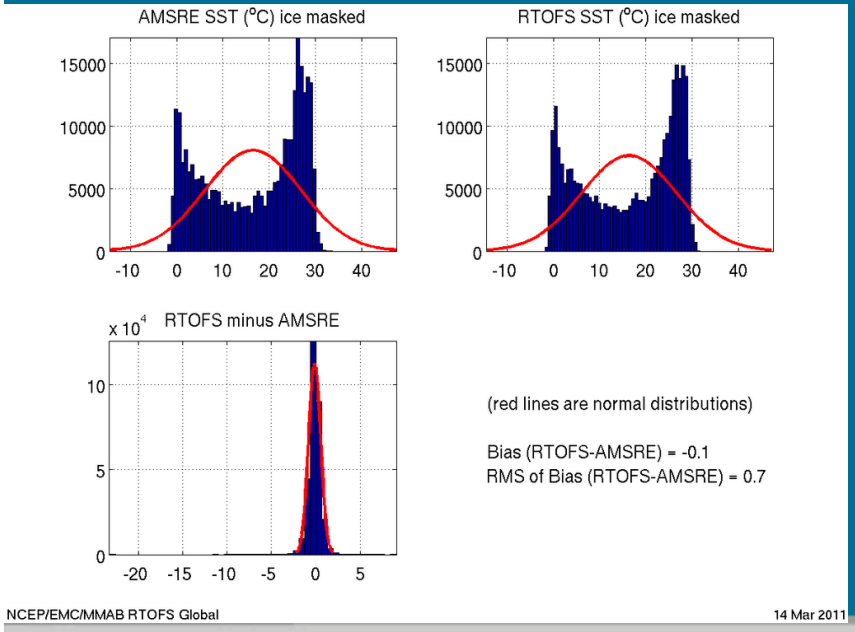


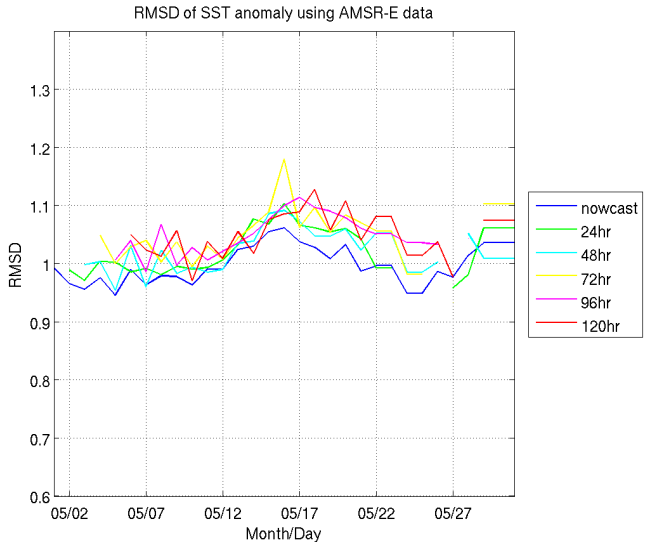


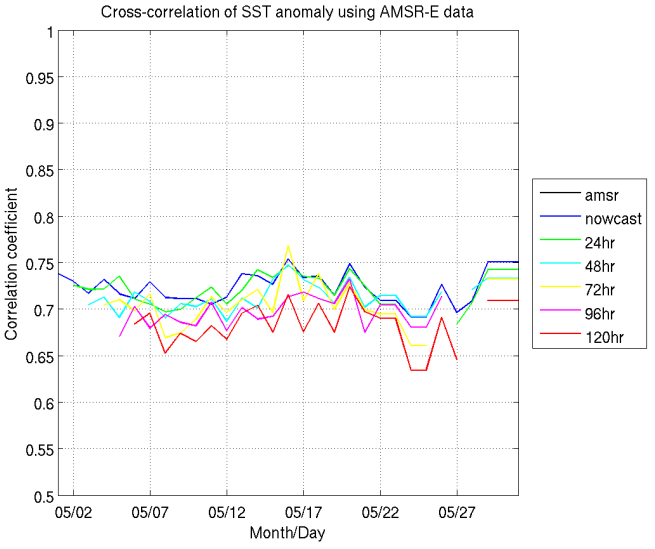


RTOFS-Global

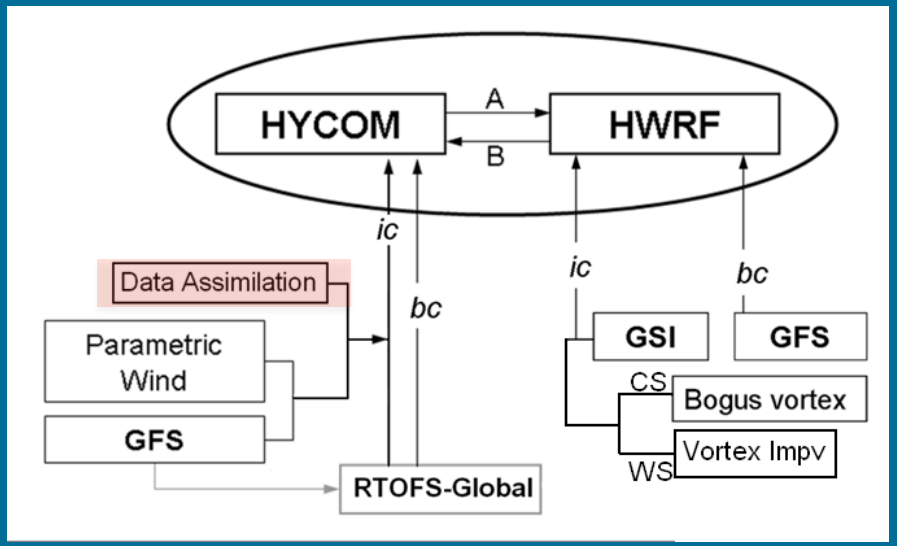


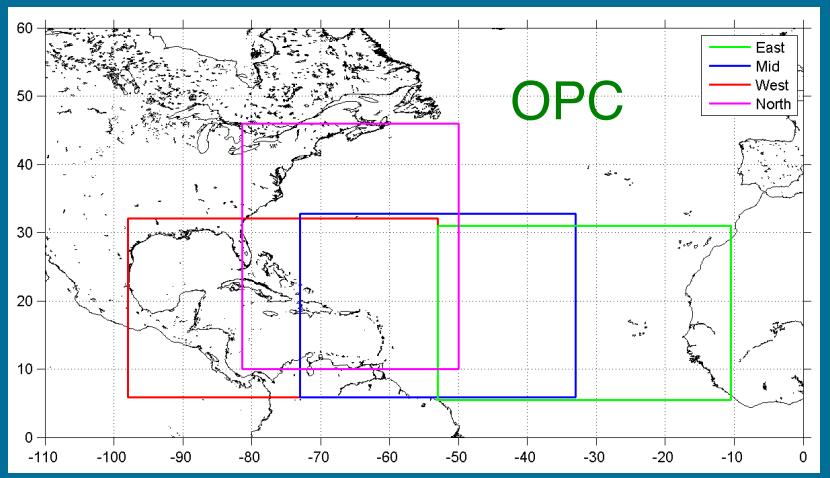


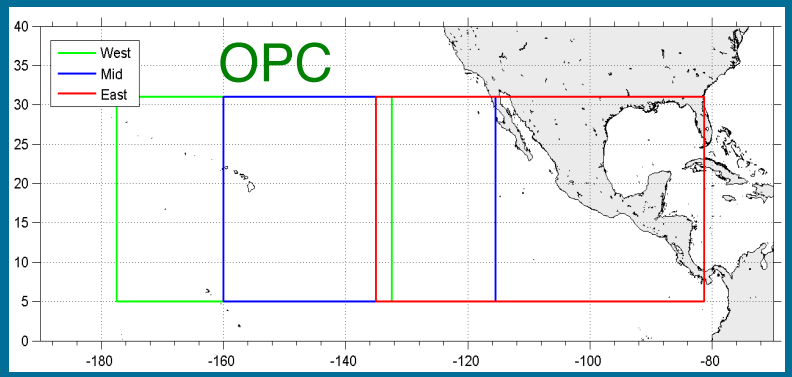


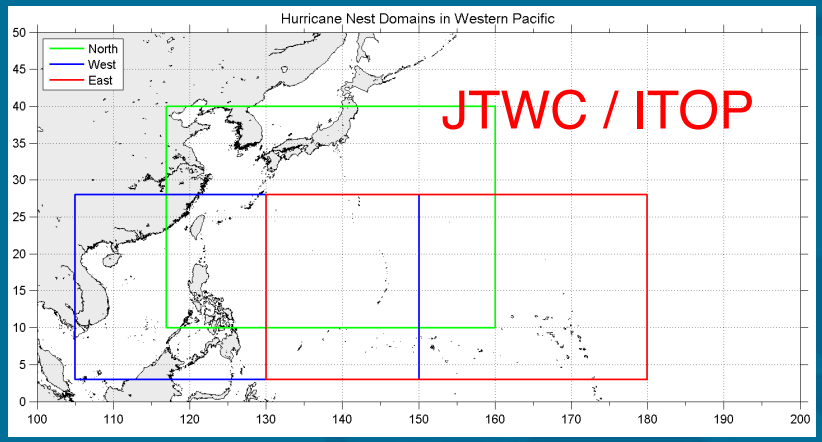


Coupled hurricane modeling with regional ocean components

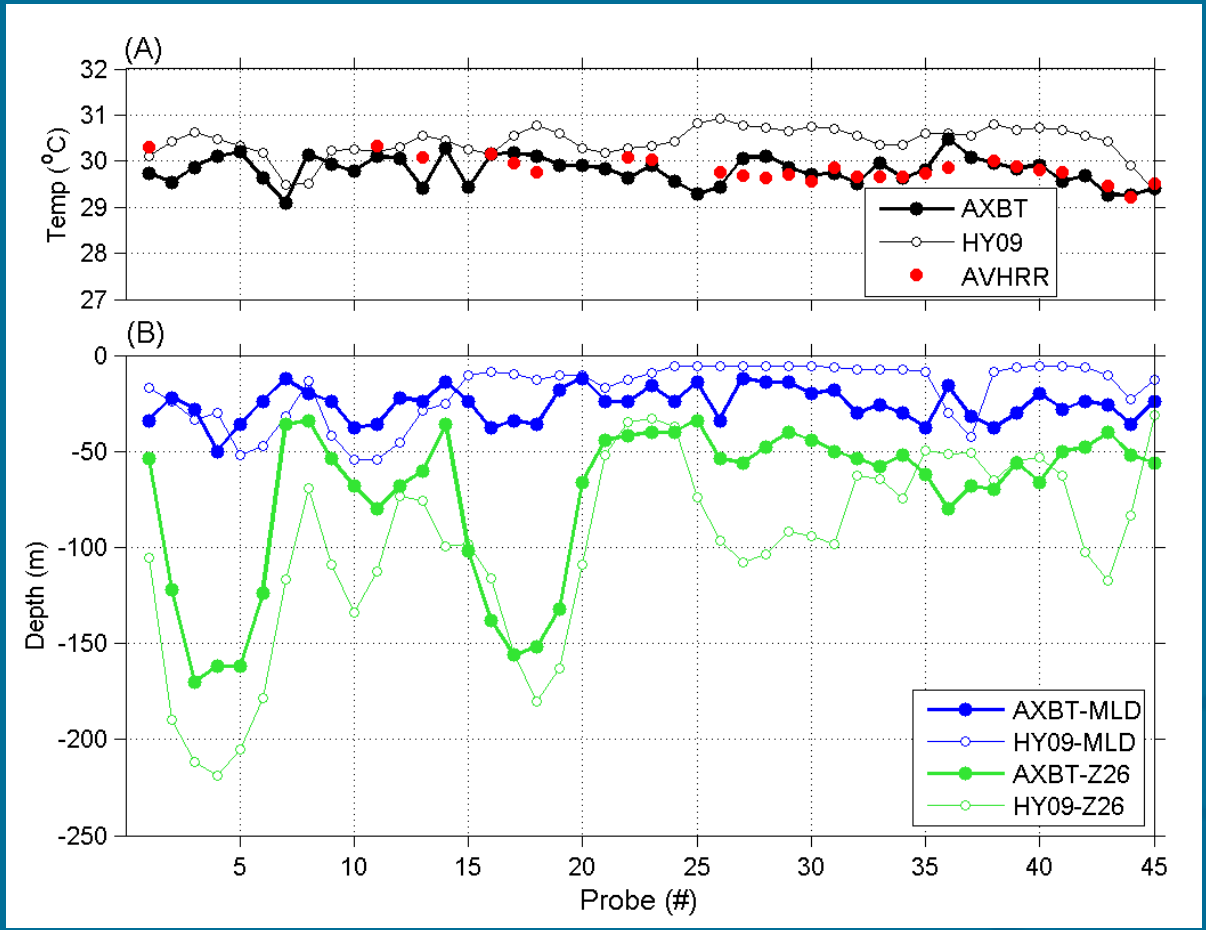






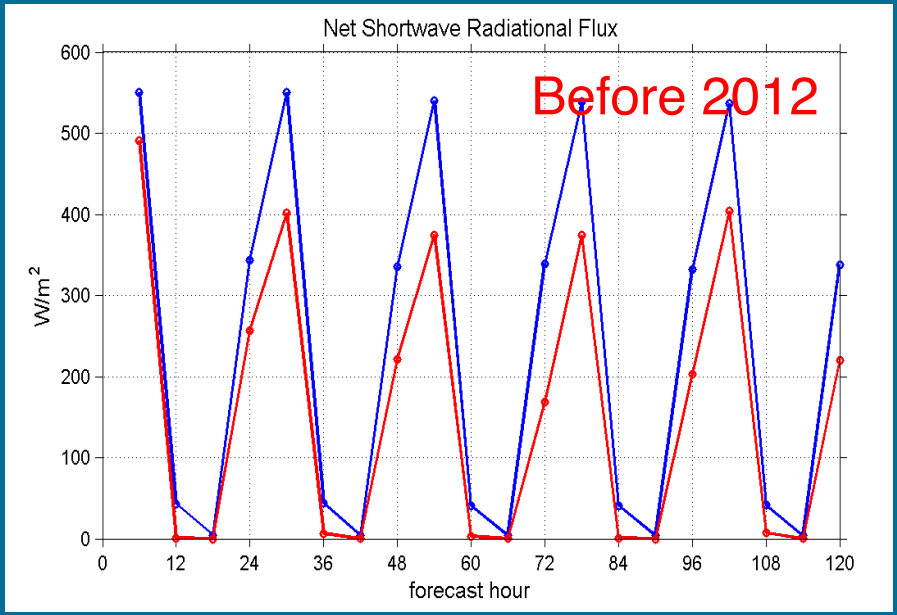


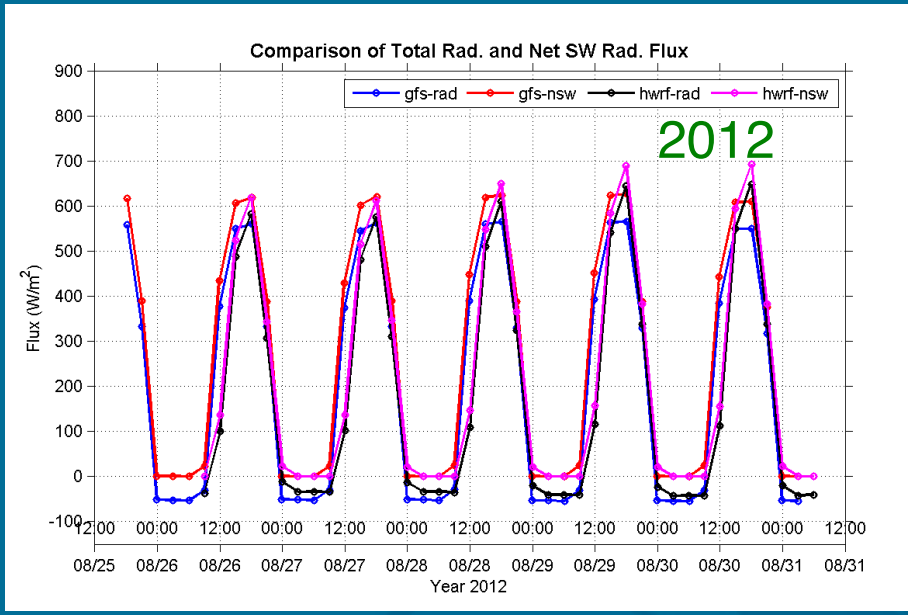
Simulations and observations for Gustav (2008)



Lessons learned:

- Coupling to different atmospheric models requires attention to models and or model-dependent flux bias correction.
- Comparison of radiation fluxes below ….

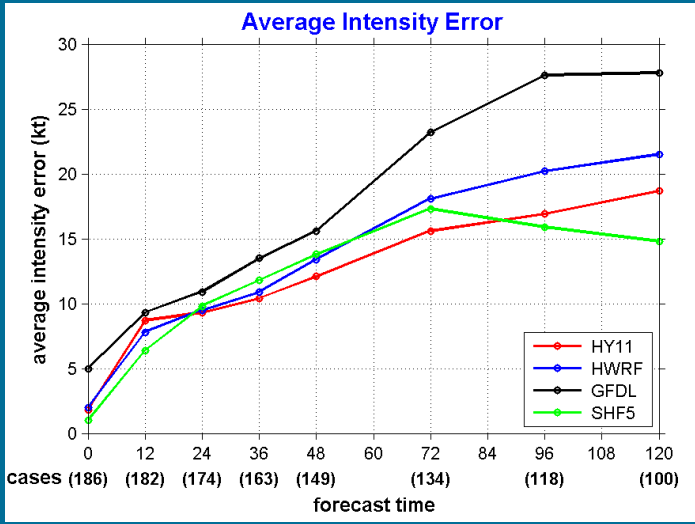


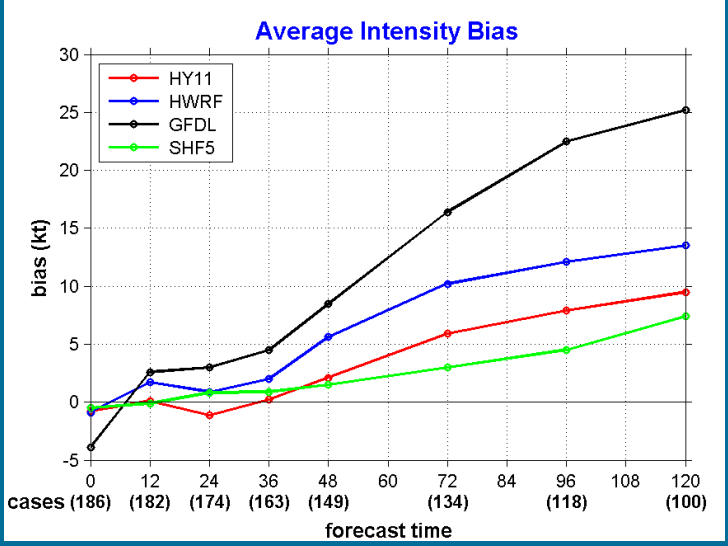


GFS – blue
HWRF – red

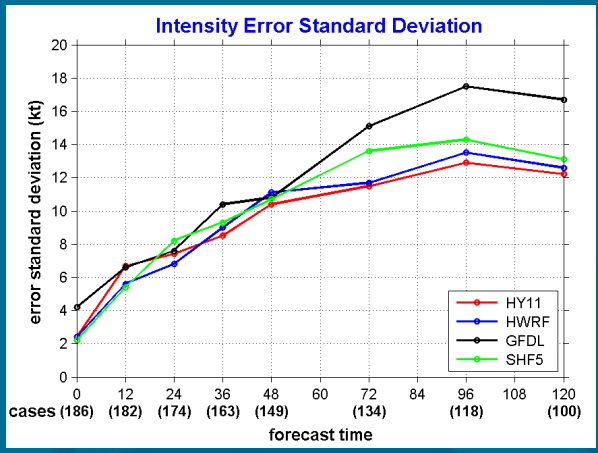
Intensity Forecast for 6 TCs (186 cases): Gert07L, Irene09L, Katia12L, Maria14L, Ophelia16L, and Philippe17L

HY11=HyHWRF2011; HWRF=operational HWRF





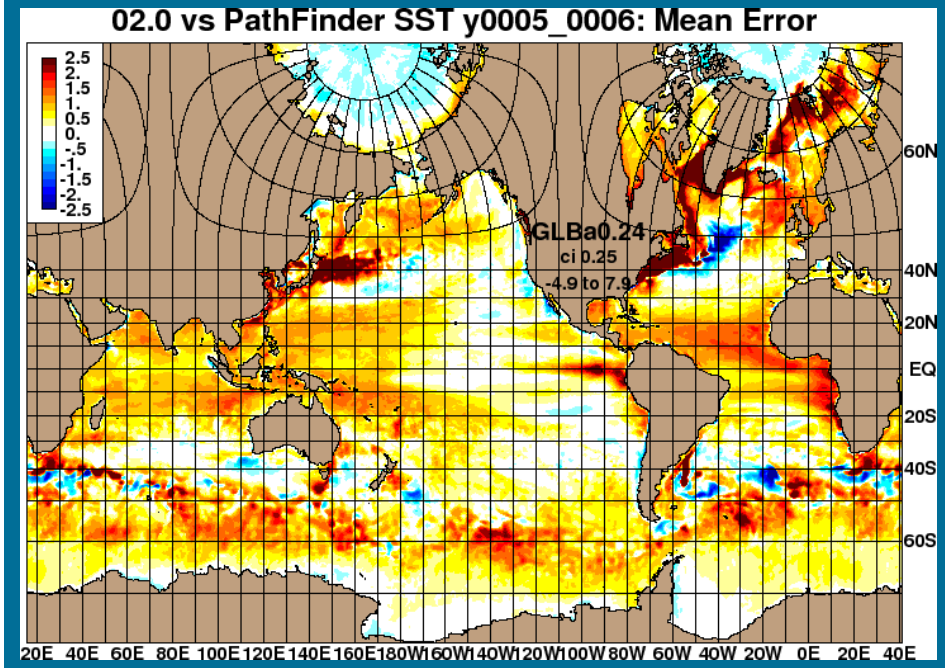
- HyHWRF average intensity error and bias are the best among participant models, except degradation at 12h in average error and negative bias at 24h.
- HyHWRF standard deviation is consistently the smallest, except 12 and 24 h.



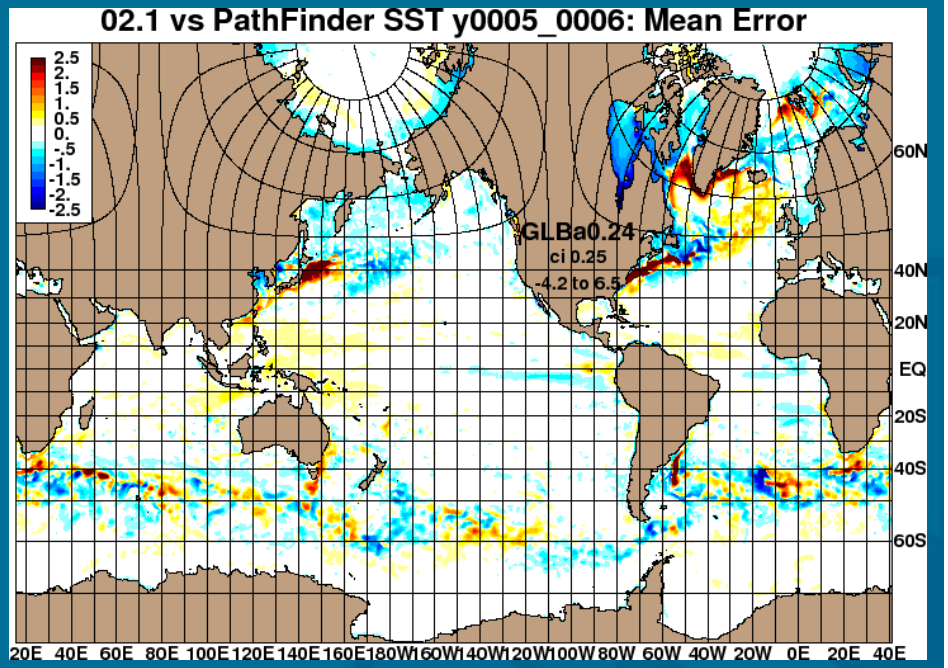
First step to coupling: manage drifts by flux correction:

- First climatological forcing, then full forcing (CFS ≈ GFS).
- vs. Pathfinder (bias), climatological years 5-6

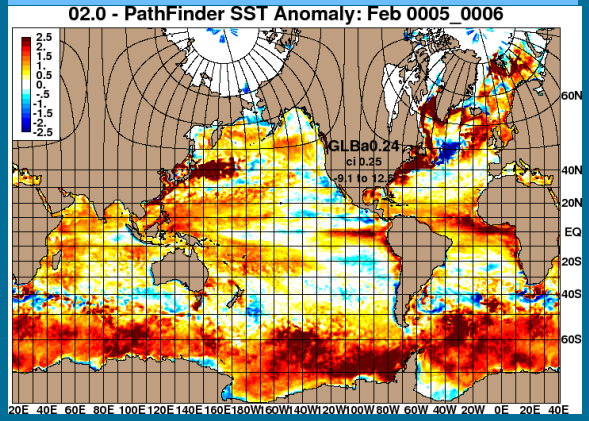
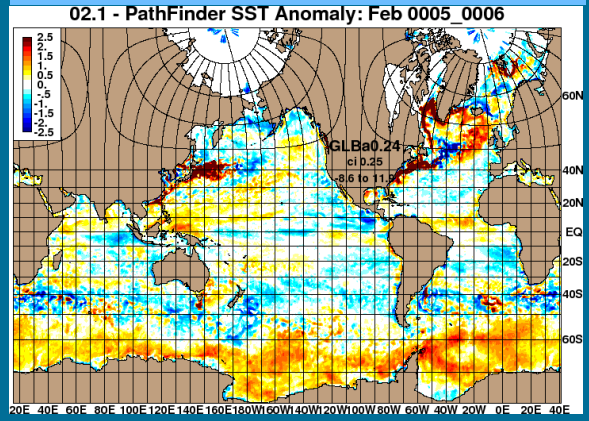
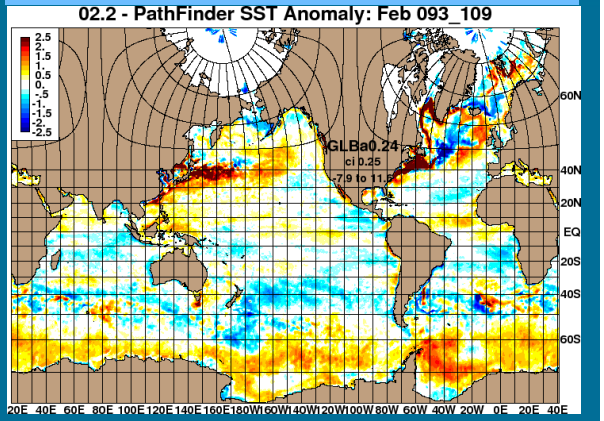
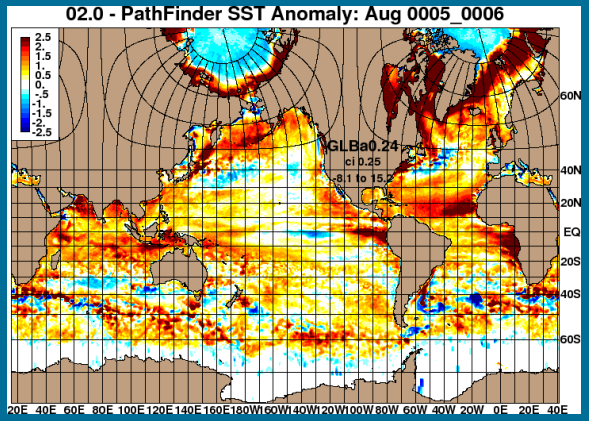
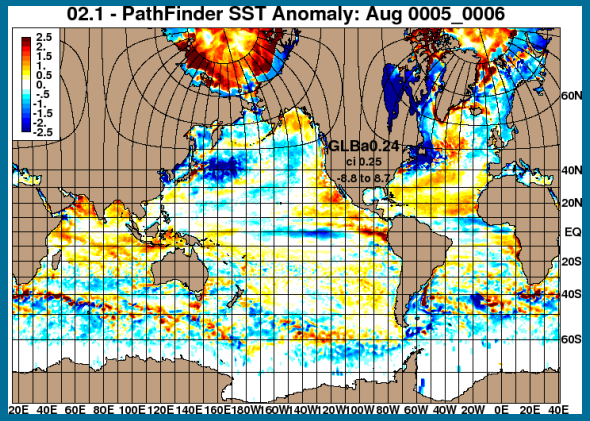
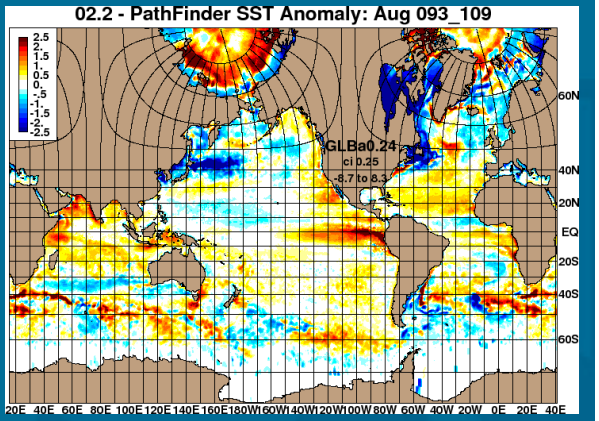
1st climatological simulation



2nd climatological simulation, with flux correction



RTOFS-NEMS

	Climatological run, no flux correction	Same but with flux correction	Interannual run, 1993-2009
Feb			
Aug			

SST mean anomalies with respect to Pathfinder

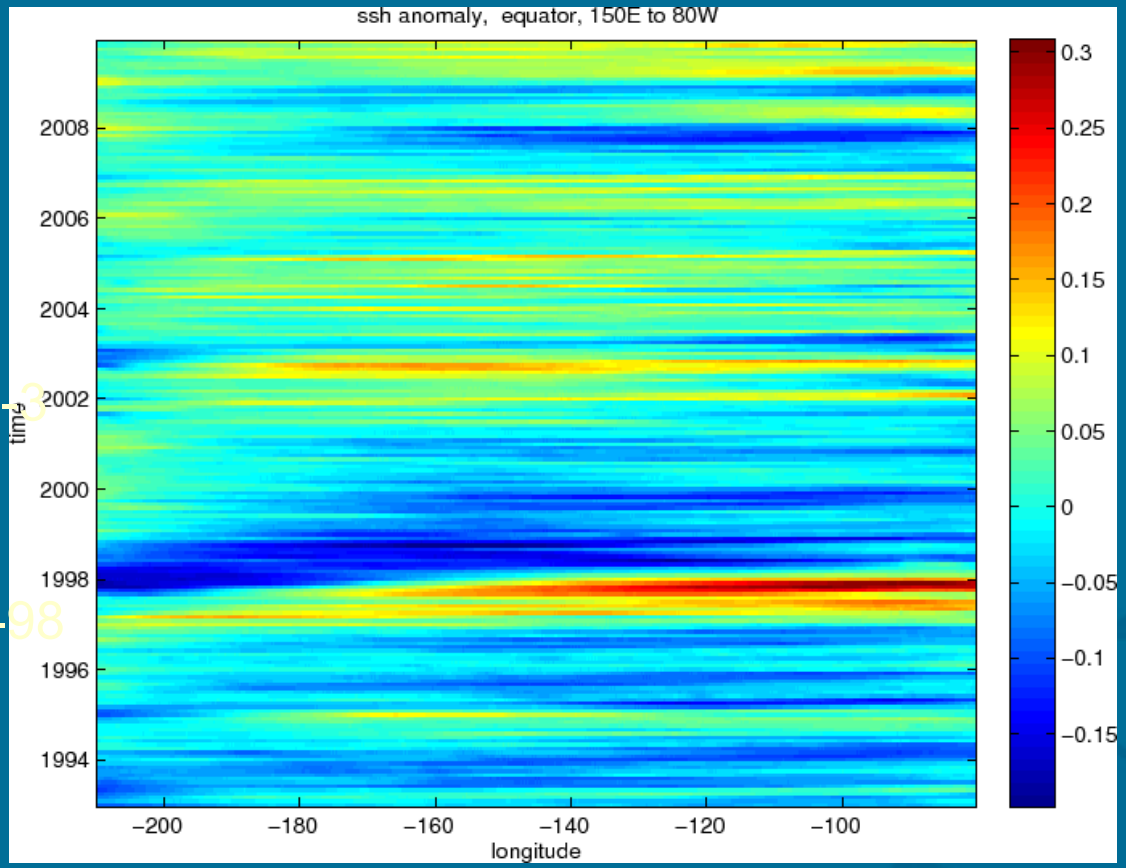
Hovmuller diagram, Pacific equatorial SSH anomaly, from monthly means

Niño 2009

Niña 2007

Niño 2002-03

Niño 1997-98



Indonesia ⟷ South America

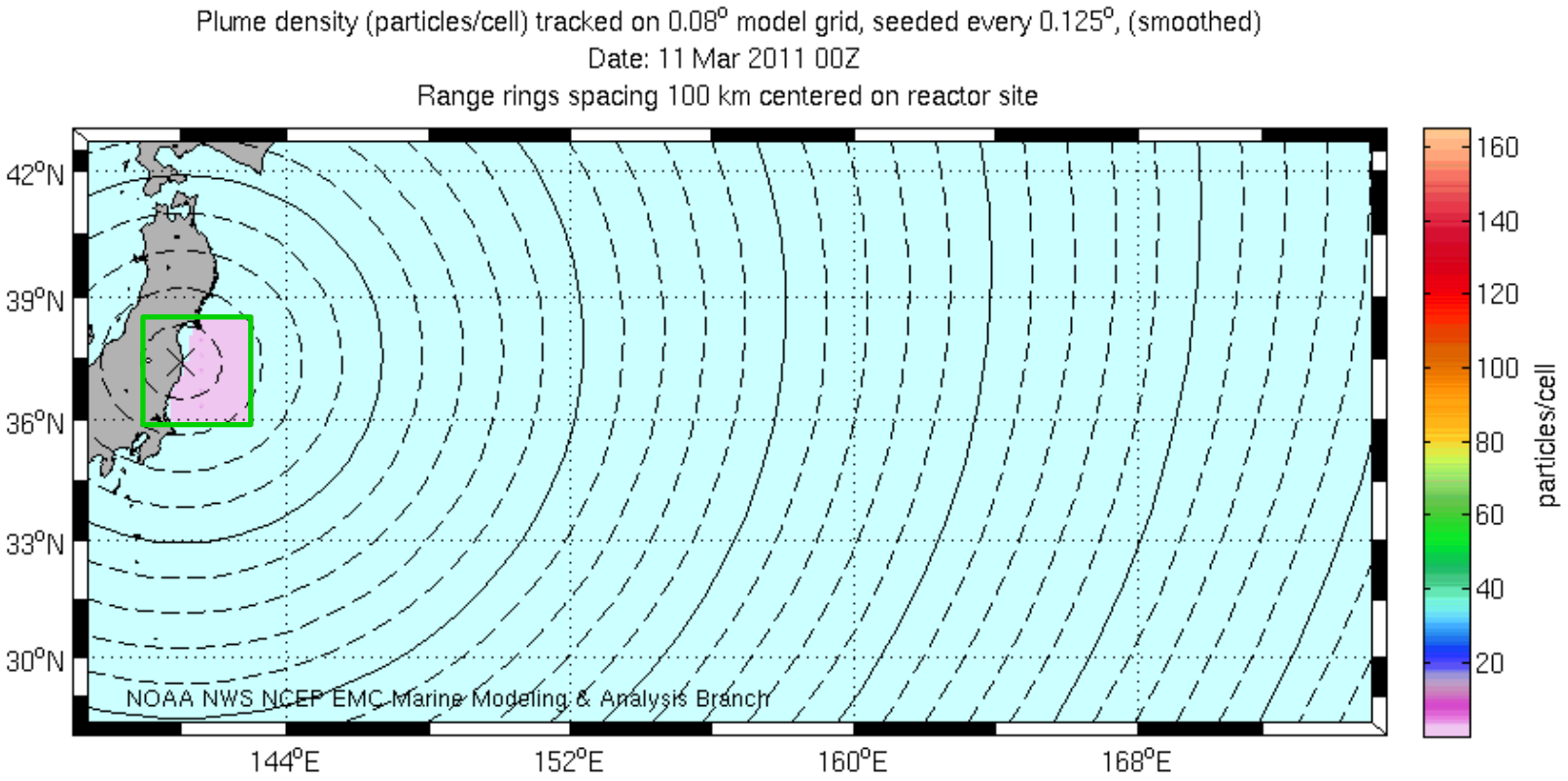
Nino34

EMC became US government lead on ocean plume modeling for Fukushima Dai'ichi ocean contamination.

- Collaboration in large Interagency work group.
- Leveraging modeling from Navy, DTRA, NOS.
  - NCEP Navy model data distribution point.
- CONOPS to rapidly generate actionable information for decision makers.
  - Product 1: Surface particle tracing to identify potentially contaminated areas. (April 6, 180 d)
  - Product 2: Contamination estimates using particle tracing + HYSPLIT atm. Deposits. (April 20, 180 d)
  - Product 3: Full dispersion model as passive decaying tracers, using direct release (NOS) and atm. deposit (NCEP) (RTOFS-ET-Pac, operational)

Example product #1

Plume density animation for first 54 days after initial release.

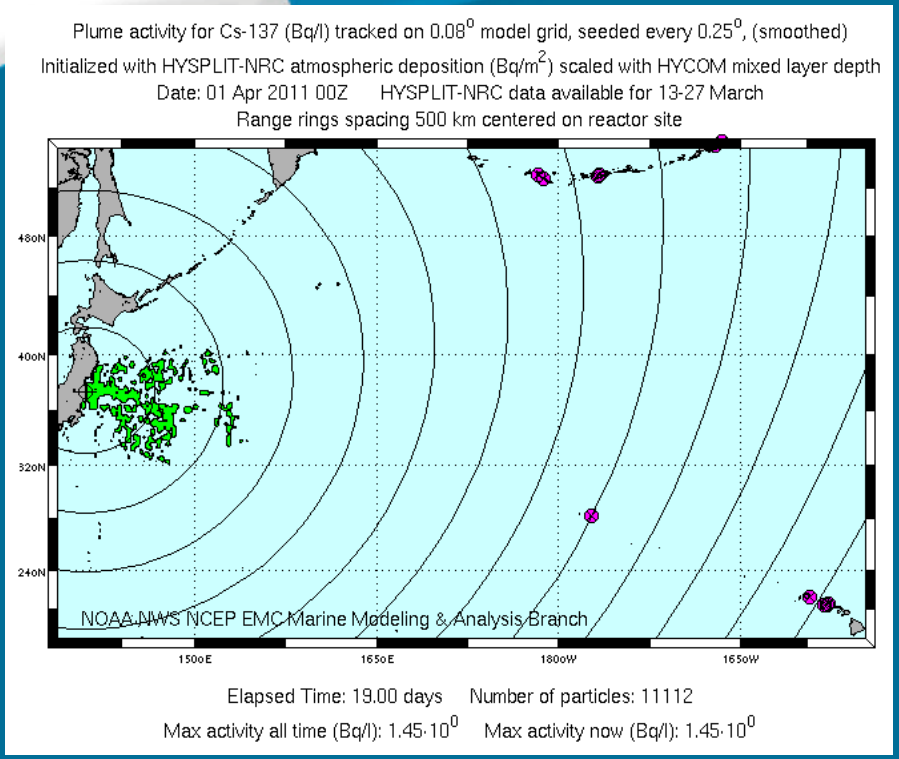


Represents possible distribution not concentration.

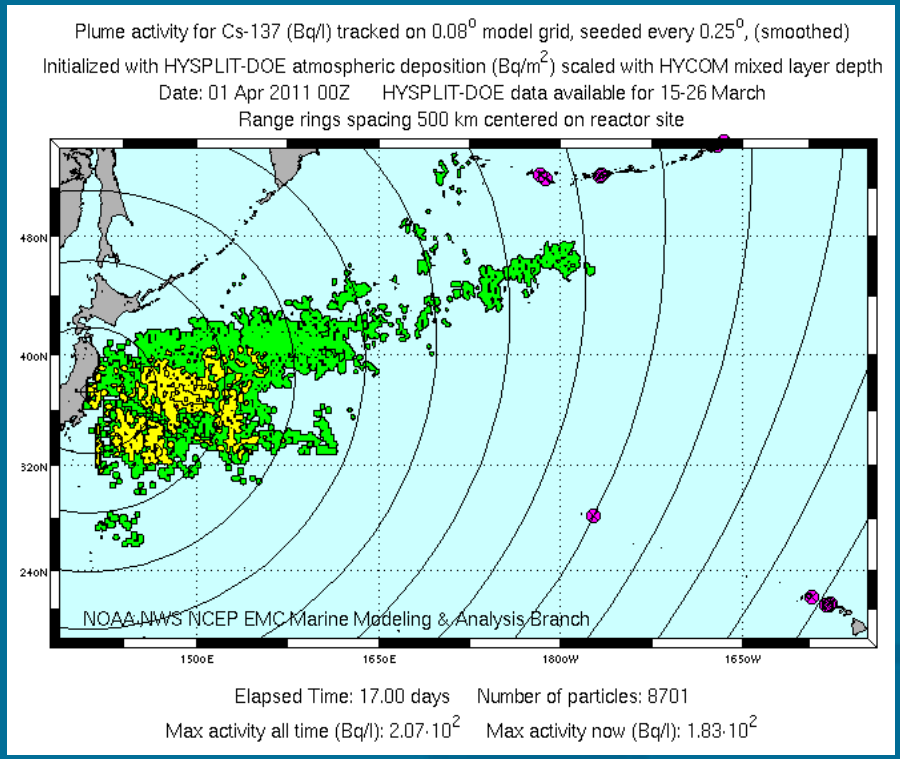
Example product #2

^{137}Cs April 1, 2011, 00 UTC

HYSPLIT-NRC



HYSPLIT-DOE



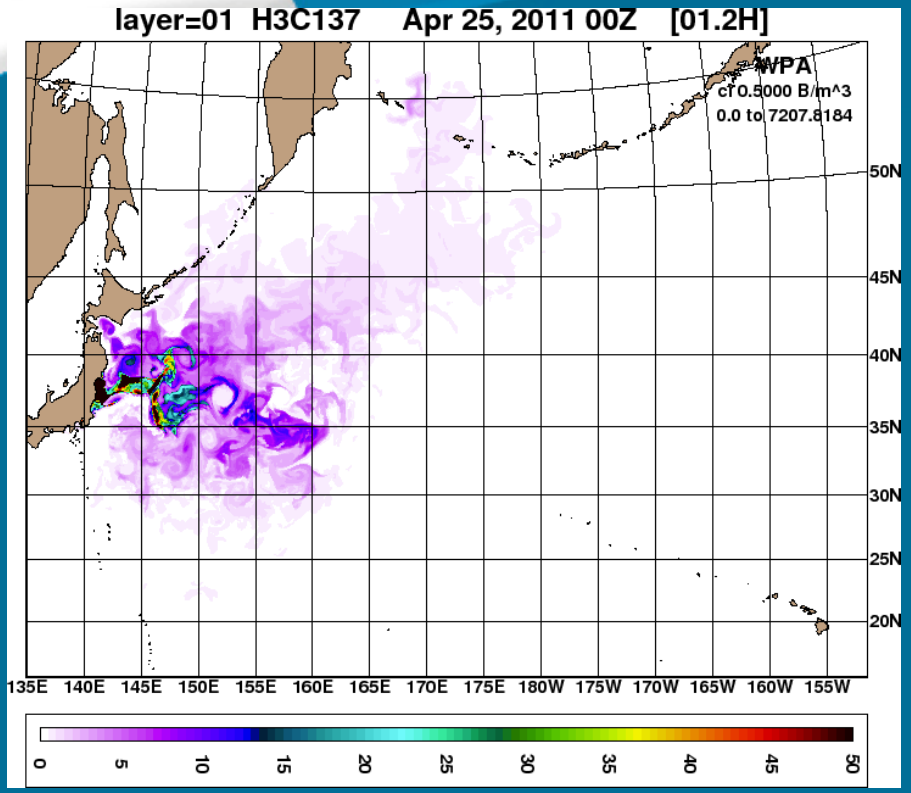
HYSPLIT-NRC and DOE differ by 2-3 orders of magnitude. HYSPLIT-NRC much too low, HYSPLIT-DOE much too high at JAMSTEC line.

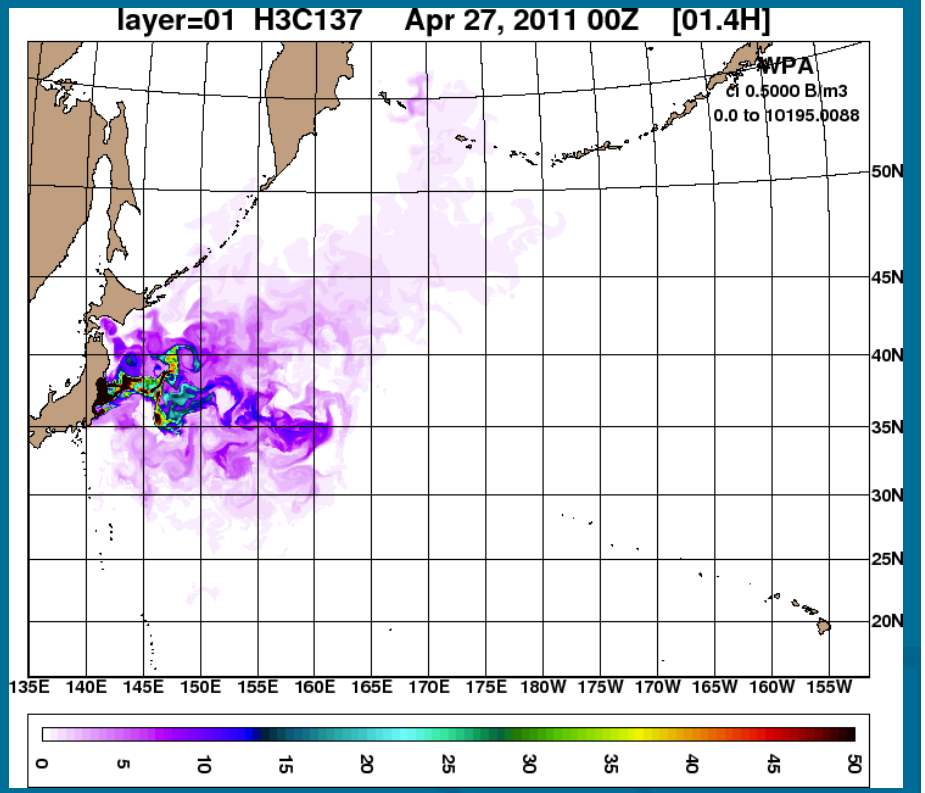
	MCL (Bq/l)	1 mrem dose (Bq/l)
^{137}Cs	7.4	33

RTOFS-ET-Pac

	MCL (Bq/l)	1 mrem dose (Bq/l)
^{137}Cs	7.4	33

^{137}Cs surface concentration (scale max: 0.05 Bq/l or 50 Bq/m^3)





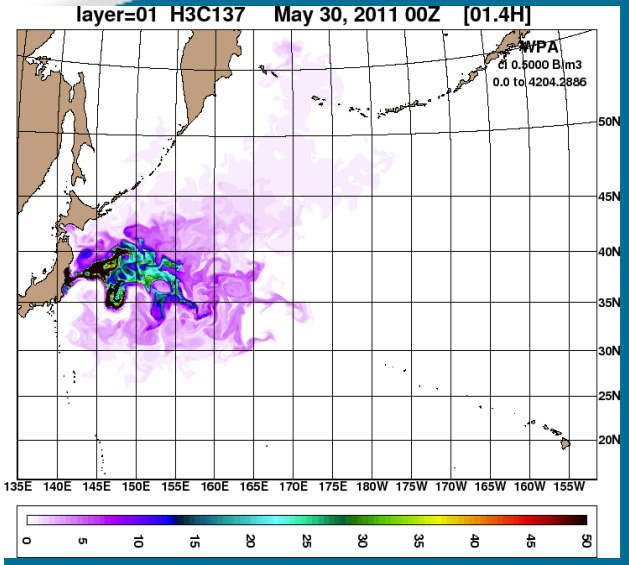
On April 25, 2011 with wet deposition from HYSPLIT data only.
Max: 7.207 Bq/l or 7207 Bq/m^3

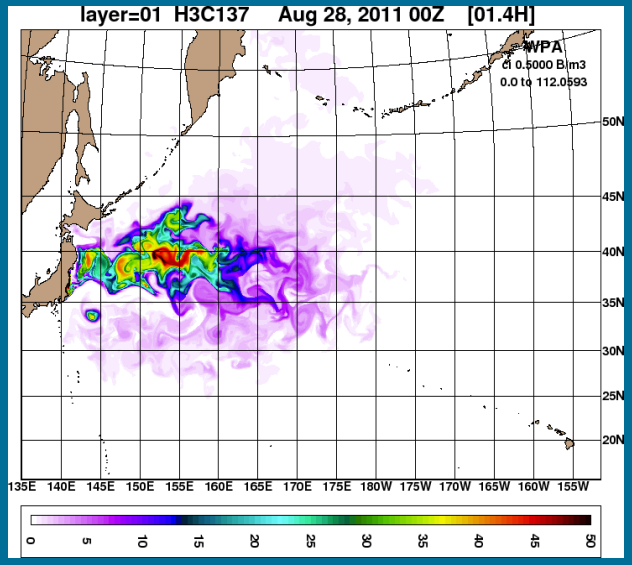
On April 27, 2011 with added direct discharge from ROMS (NOS-CSDL).
Max. 10.195 Bq/l or 10,195 Bq/m^3

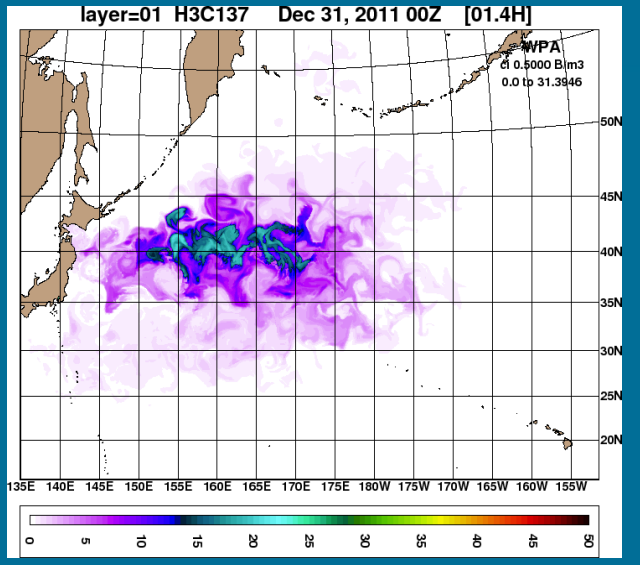
RTOFS-ET-Pac

	MCL (Bq/l)	1 mrem dose (Bq/l)
^{137}Cs	7.4	33

^{137}Cs surface concentration (scale max: 0.05 Bq/l or 50 Bq/m^3)







On May 30,2011
Max: 4,204 Bq/m^3

On Aug 28,2011
Max: 112 Bq/m^3

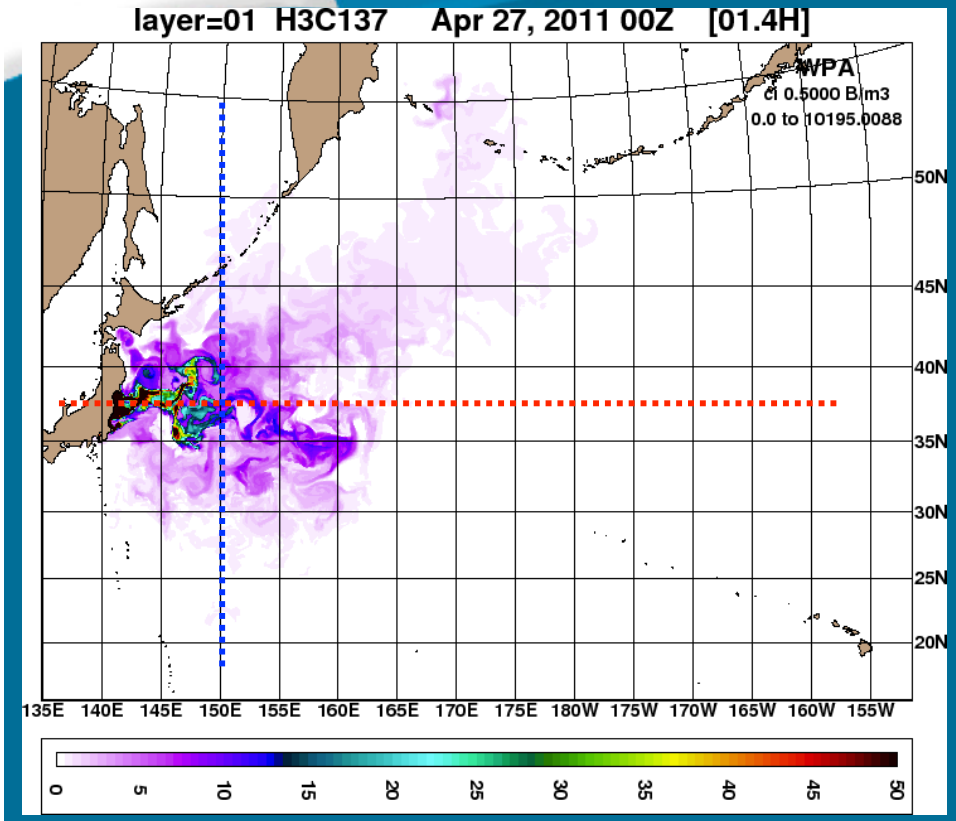
On Dec 31,2011
Max: 31 Bq/m^3

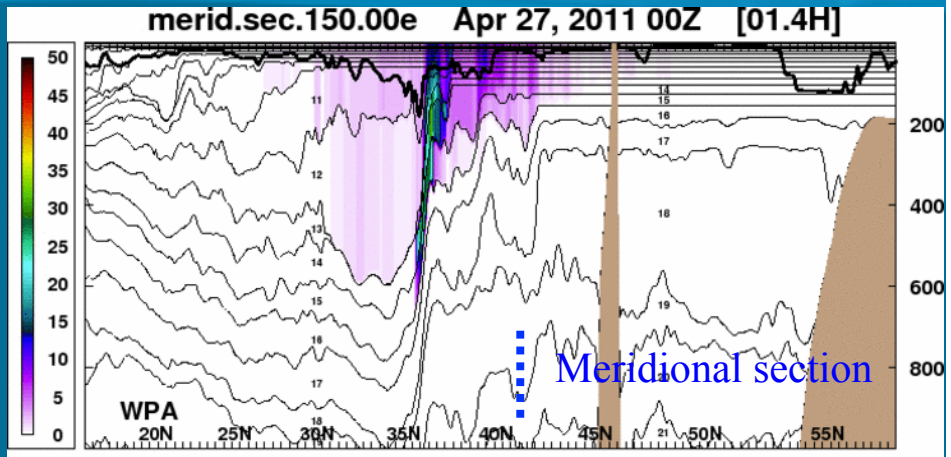
The surface concentrations are diluted as they propagate eastward.
Note MCL (drinking water) 7,400 Bq/m^3
Existing background level approximately 3-5 Bq/m^3 (1990)

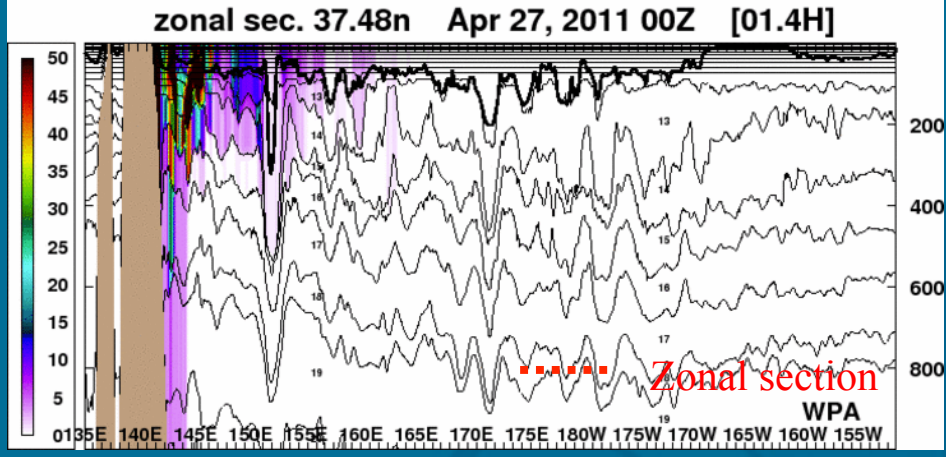
	MCL (Bq/l)	1 mrem dose (Bq/l)
^{137}Cs	7.4	33

RTOFS-ET-Pac

http://polar.ncep.noaa.gov/global/tracers







^{137}Cs surface concentration
(scale max: 0.05 Bq/l or 50 Bq/m^3)

Simulated results after atmospheric (HYSPLIT) and coastal (ROMS) sources were combined (April 27, 2011 ~ December 31, 2011)

Future / needs

- Atlantic:
  - What is future of model ?
- Global:
  - Build capacity: focus on DA with Navy.
- HWRF:
  - Get implemented, architecture of coupling.
- NEMS:
  - Development in ESMF / NEMS environment.
    - Weather coupling, possible CFS-v3 (MME).
- ET:
  - Develop stand-by capabilities for emergency response.
    - CONOPS focused, ecosystems modeling link.

- General: coupling wind waves and ice.


Thank you!